Docket No. 42701-1001
Express Mail No. EL591767819US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

METHOD FOR TRANSMITTING AND STORING VALUE AND VALUE STORE ELECTRIC POWER METER USING THE SAME

Inventor: **Seung-ho Tak**

METHOD FOR TRANSMITTING AND STORING VALUE AND VALUE STORE ELECTRIC POWER METER USING THE SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a value store electric power meter of a new concept, and more particularly, to a value storing method by which the server of an electric power supplier or an electric power re-seller transmits a value through a power line modem and stores the value in a store value module (SVM) or an IC card and an electric power meter of advance and direct payments without requiring a metering.

2. Description of the Related Art

A conventional watt/hour meter for measuring the amount of consumed electricity per hour in a certain period by a meter man has been used so far in all institutions consuming electricity such as a home, an office, and a public building. Such a first generation electric power meter is managed in a very complicated and expensive way wherein a meter man visits places in which the electric power meters of homes and businesses are installed and checks the difference between the amount of power consumed at the previous measurement and the power consumption amount at the measuring point in time, i.e., the amount of consumption in a month or a certain period. A calculation of supply and consumption results is completed by the supplier and a bill is printed and mailed to the consumer after performing a computational process such as a data input and a calculation of the consumption amount, a consumer taking a request for payment paper and making payment, and processing the request. The bill must be mailed once again for processing arrears and nonpayment.

As burglars pretending to be meter men have appeared and measuring costs contribute to a large part of electric power supplying costs due to the increase of the personnel expenses of meter men, a remote measuring electric power meter which is a second generation product is under consideration as a

new measuring method and is currently not widely applied. It is possible to reduce the personnel expenses of meter men by the remote measuring electric power meter. However, the consumption amount every month must be computer processed, the bill must be mailed, and the arrears must be processed. In particular, the management of the remote measuring electric power meter with respect to gas and water meters, which requires additional power, and communication lines such as a telephone line, or a radio, are avoided by the supplier and the consumer. This is due to the rise in cost caused by the operation between the gas and water meters, the server of a remote measuring center and the installation and operation of communication equipment according to the addition of a communication function for remote measuring.

Therefore, an IC card payment electric power meter of a third generation which requires no visual measuring can be considered. The IC card payment electric power meter can solve the problems of the electric power meters of the first and second generations to some extent. However, the effectiveness of the IC card payment electric power meter depends upon how to perform processes of re-charging and calculating value information in an IC card. In particular, when electric power is cut out due to the complete consumption of the value information on the IC card, an unexpected accident may occur.

SUMMARY OF THE INVENTION

It is a first object of the present invention to provide value transmitting and storing methods in which the server of an electric power supplier or an electric power re-seller communicates with value store electric power meters of the respective subscribers, stores value in a store value module (SVM) inside the value store electric power meter according to the present invention, and transmits added credit value information to and stores added credit value information in an IC card. Accordingly, suppliers or re-sellers create a high added value for consumers by increasing the effectiveness of management and considerably reducing the price of electric power.

It is a second object of the present invention to provide a value storing method for storing value on the IC card by which it is possible to use credit value

information transmitted through a power line modem with all the meters in homes and factories, such as a gas meter, a water meter, and a calorimeter for measuring heat energy, which are installed and operated on an off-line basis.

It is a third object of the present invention to provide a value store electric power meter by which it is possible for the electric power supplier or the electric power re-seller to increase the effectiveness of management by communicating with the host of an authenticated agency through the power line modem and transmitting the credit value information to and storing the credit value information in the IC card. Accordingly, it is possible to reduce the price of electric power to consumers by remarkably reducing incidental expenses related to electric power supply and to omit inputting and calculating the amount of consumed electric power during a certain period, through the use of a server for printing bills, and mailing and calculating the bills.

It is a fourth object of the present invention to provide a value store electric power meter by which it is possible to completely solve all the problems of the electric power meters of the first, second, and third generations, to swiftly and easily re-charge value, and to charge the added value on the IC card using a value charging channel. Accordingly, the value store electric power meter can be applied to various meters such as the gas meter, the water meter, and the calorimeter. Accordingly, it is possible to maximize the effectiveness of various businesses.

Accordingly, to achieve the above objects, there is provided a value store electric power meter for communicating with the server of the electric power supplier through a power line modem included in the electric power meter, storing value information in a value store module inside the electric power meter, calculating value according to the amount of electric power consumption, and stopping electric power supply when a credit value is completely consumed.

According to an aspect of the present invention, there is provided a method for storing credit information in a value store module in a value store electric power meter by communication between a host and each terminal through an electric power modem included in the value store electric power meter which is a terminal, comprising the steps of (a) the host generating first random data,

sending the first random data to a terminal, generating a session key by a key generating algorithm using a terminal intrinsic secret key, generating a first signature value by a signature generation algorithm for a comparison during a terminal authentication, and the terminal receiving the first random data and generating the session key by the same method as the host, (b) the terminal generating a second signature value by a signature generating algorithm and second random data and sending the second random data to the host, (c) the host comparing the first and second signature values and authenticating the terminal, the host generating a third signature value and sending the third signature value to the terminal with information on an amount of money when the terminal is authenticated and the terminal receiving the third signature value and the information on the amount of money from the host, generating a fourth signature value, and authenticating the host by comparing the third and fourth signature values with each other, and (d) the terminal increasing the value by decoding the information on the amount of money and sending the value obtained by encrypting a balance and a terminal ID using an encrypting algorithm to the host and the host receiving the encrypted value, decoding the encrypted value, comparing the stored terminal ID with the decoded terminal ID, authenticating the terminal once again, and backing up the balance in a record file when the authentication is completed.

According to another aspect of the present invention, there is provided a value store electric power meter including an electric power line input and output terminal for measuring the amount of used electric power, comprising an electric power consumption operating portion for measuring the voltage and current of an electric power line and calculating used electric power, an electric power modem for performing data communication between the host and the terminal through the electric power line, a secure storing portion including a secure access module (SAM) having a CPU and an encryption key and an encryption algorithm for storing value and a store value module (SVM) for storing value, for preventing the fraudulent use of the value information and hacking, excluding a cryptographical attack, and requiring the authorization process of the SAM in requesting a token from the SVM, an on/off latch relay switch for breaking the supply of electric power according to the balance result of the SVM, and a token exchanger for reducing a

token from the value information input from the SVM according to the amount of electric power consumed per unit time, the SVM requesting a new token to a token tank when an inner token is exhausted.

Preferably, the value store electric power meter further comprises an IC card reading and recording portion to allow use with other meters such as water, gas, and calory meters by inserting an IC card into the electric power meter, receiving value from the host on-line, recording the received value on the inserted IC card, and reading the received value from the IC card.

Preferably, the IC card reading and recording portion is applied to water, gas, and heat meters employing an IC card method operated in an off-line state by recording added value for things such as gas and water in the IC card through the electric power modem, by which it is possible to store electric power value in the IC card by including a communication port comprised of eight terminals defined by the ISO 7816 Part 2 having Vcc, Clk, DIO, Reset, and Gnd for synchronously and asynchronously communicating with the IC card.

Preferably, the value store electric power meter further comprises an AC/DC converter for supplying an operation voltage required by the electric power meter, a power consumption sensor for sensing that the electric power is normally used when the output of a sensor is "0" and that terminals are bypassed and the electric power is surreptitiously used when the output of the sensor is "1", and a buzzer for generating an audible alarm and guiding a user to perform value transfer and storage when a last token is received by requesting a new token from the SVM after the balance of the token exchanger is exhausted.

Preferably, the electric power consumption operating portion comprises a shunt resistor for measuring an amount of AC current, a voltage divider for serially connecting two resistors and selecting from a voltage range given by the ratios of the two resistors in order to adjust the AC voltage of the electric power line within the range of the input voltage of a voltage meter, an analog to digital converter for converting an AC current signal which flows through the shunt resistor into a digital signal of 16 or 20 bits, and an analog to digital converter for converting an AC voltage into a digital signal of 16 bits, wherein the phase of the voltage is compared with the phase of the current and an angle by which the two phases are

different from each other is calculated and output as a signal for applying differential rates.

Preferably, the value store electric power meter further comprises an electric power consumption table which is an electric power fee mode table for differentially applying multiple step electric power use rates such as 50%, 75%, 100%, 150%, and 200% according to electric power supply and demand states on the basis of a real time clock comprised of year, month, time, minute, and second.

Preferably, the value store electric power meter comprises a non-volatile memory storing a characteristic 3 byte ID number and recording an electric power use state during a certain period of hours, days, or months for remotely monitoring the surreptitious or abnormal use of electric power and performing an electronic sealing function.

Preferably, the value store electric power meter comprises an LCD display for visually displaying the balance of the value, the transfer state of the value, the real time electric power consumption status, and the accumulative electric power use states.

The value store electric power meter which can be used for simple and sound fee payment means by a SET electronic commercial transaction process using next generation credit and direct payment cards of EMV '96 mixed with the IC card reader and recorder, further comprises means such as a telephone, an Internet, a P-ATM (EMV '96), and a digital interphone for performing audio communication with a person in charge of the host server or transmitting an audible message to help the user with matters such as storage and a keypad for a user directly requesting the value to be stored.

Preferably, the electric power input and output terminal of the electric power meter comprising a cover and physical sealing for preventing physical tapping, prevents the surreptitious and abnormal use of electric power.

Preferably, the value store electric power meter further comprises an arrester circuit for absorbing lightning or a surge voltage on an electric power line of a supplier.

Preferably, the electric power meter can request a voice message from a person concerned with the service by a speaker and a key pad switch of a digital

intercom. Processes of transmitting and storing credit value are facilitated by a person concerned with transmitting the voice message service to a subscriber.

BRIEF DESCRIPTION OF THE DRAWING(S)

The above objects and advantages of the present invention will become more apparent by describing in detail a preferred embodiment thereof with reference to the attached drawings in which:

FIG. 1 is a flowchart illustrating a method for transmitting and storing value according to the present invention;

FIG. 2 is a flowchart illustrating the flow of multi-step differential charge mode correcting commands (the exchange of an electric power charge system) by hours, days, months, and seasons applied to a value store electric power meter according to the present invention;

FIG. 3 is a flowchart illustrating processes for monitoring an abnormal consumption of electric power such as conductance and preventing an illegal consumption by comparing the total power used by subscribers to the electric power meter according to the present invention per unit of time, such as days, weeks, or months, with the total amount of electric power consumption per unit time;

FIG. 4 schematically describes a signature generating method and an encryption method applied to the present invention;

FIG. 5 is a block diagram showing the inner structure of the value store electric power meter according to the present invention;

FIG. 6 shows the structure of a system according to the present invention for describing the flow of the value information; and

FIG. 7 is a split perspective view showing the exterior view of the value store electric power meter according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, a method of transmitting and storing value according to a preferred embodiment of the present invention and the structure and operation of

a value store electric power meter without the need for visual measurement by a meter using the same will be described in more detail.

The present invention can be applied to an electric power meter, a gas meter, a water meter, and a calorimeter, employing direct payment and pre-payment calculating methods mixed with an electronic purse method. Here, the present invention will be restricted to the electric power meter for convenience sake. Also, in all the communication processes of transmitting and storing value according to the present invention, a basic encryption algorithm triple-DES is applied. Communication between a server host and an electric power meter terminal is performed as follows. First, a task of making a session key (Ks) is performed in the server and the terminal. An encryption algorithm triple-DES is applied through the session key. Also, when a task of making a signature is necessary, a MAC CBC using the triple-DES is used. When values are stored in the electric power meter terminal, a value storage, an electric power use calculating mode table, a unit charge, and a time to be corrected are stored. When values are read from the electric power meter terminal, the credit balance, date, month, and year use details, the electric power use calculating mode table, the unit charge, and timer hours are read, thereby providing information to detect abnormal use.

First, before describing the method for transmitting and storing value according to the present invention, examples of the signature generation and the encryption algorithm applied thereto will be described hereinafter with reference to FIG. 4.

After the task of making the session key (Ks) is performed in the server and the terminal through communication between the server and the value store electric power meter, the encryption algorithm triple-DES is applied through the session key (Ks). The MAC CBC using the triple-DES can be used for the task of signature generation. Hereinafter, the signature generation and the encryption algorithm will be described in more detail with reference to FIG. 4.

For the signature generation, the magnitudes of original data are made multiples of 64 bits by applying padding in step 1. These are D_1, $\cdots$, and D_N of FIG. 4. In step 2, the data values (D_n) of the 64 bits are F encrypted, applying

triple-DES, according to an input key (K). Signature values are O_1, $\cdots$, and O_N of step 3. At this time, values obtained by adding the respective data values (D_n) to signature values (O_{N-1}) except for a first signature value O_1 are F encrypted.

For the encryption, the magnitudes of original data are made multiples of 64 bits by applying padding in step 1. These are D_1, $\cdots$, and D_N. In step 2, the triple-DES algorithm is applied to the F encryption. The encrypted messages are $O_1 + \cdots + O_N$ of step 3.

A master key (KH) of the host, an intrinsic secret key (KT) of each terminal, and a secret session key (Ks), used in a communication process, each having a magnitude of 128 bits, are used. The terminal intrinsic key (KT) is generated from the master key (KH) of the host. The session key (Ks) is generated from the terminal intrinsic key (KT). The master key of the host (KH) and the terminal intrinsic key (KT) are arbitrarily selected from various sets.

The terminal intrinsic key (KT) is generated by encrypting the ID of the terminal by the triple-DES algorithm using the master key (KH) of the host. An intrinsic key is stored in the terminal in a generation step and is generated in the host in an initial stage of communication. Namely, KT = Encrypt (ID, KH).

The session key (Ks) is generated by encrypting random numbers R generated in the host by the triple-DES algorithm using the terminal intrinsic key (KT) whenever communication is performed. All the encryptions are performed using the session key (Ks) in the communication process. Namely, Ks = Encrypt (R,KT).

In the present invention, algorithms of (1) a value store command, (2) a differential charge mode control command based on hours, days, months or seasons), and (3) use during days, weeks, or months and timer information check command (abnormal monitoring are adopted) are adopted. These will be described with reference to FIGs. 1 through 3.

First, the flow of the value store command will be described with reference to FIG. 1.

STEP 10: The host generates first random data (R1, R2, and n) and sends the first random data to the terminal. The session key is generated by the key generation algorithm using the terminal intrinsic secret key (KT[n]). Namely, Ks =

Encrypt (R1, KT[n]). For comparison during a terminal authentication, a first signature value S1h = Sig (R2, Ks) is generated by the signature generation algorithm. The terminal receives the first random data (R1, R2, and n) and generates the session key as done in the host using the terminal intrinsic secret key (KT[n]). Namely, Ks = Encrypt (R1, KT[n]).

STEP 12: The terminal generates a second signature value S1t = Sig (R2, Ks) by the signature generation algorithm, generates second random data R3, and sends S1t and R3 to the host.

STEP 14: The host can authenticate the terminal by comparing S1h with S1t. When the terminal is authenticated, the host generates a third signature value S2h = Sig (H+R3+EnAmnt, Ks) and sends S2h to the terminal with encrypted total amount of money information (EnAmnt). Here, H is a header representing the value store command. The terminal generates a fourth signature value S2t = Sig (H+R3+EnAmnt, Ks) and authenticates the host by comparing S2h with S2t.

STEP 16: When the host is authenticated, the terminal increases the value, encrypts Balance + ID as M = Encrypt (Balance+ID, Ks), and sends the encrypted value M to the host. The host authenticates the terminal once again by decoding the encrypted value M as Balance'+ID'=Decrypt (M, Ks) and comparing ID' with ID. When the terminal is authenticated, the balance is stored on a record file.

The flow of the differential charge mode control command based on hours, days, months, and seasons (the charge system) will be described with reference to FIG. 2.

STEP 20: The host generates the first random data (R1, R2, and n) and sends the first random data to the terminal. The session key is generated by the key generation algorithm using the secret key (KT[n]). Namely, Ks=Encrypt (R1, KT[n]). For the comparison during the terminal authentication, the first signature value S1h=Sig (R2, Ks) is generated by the signature generation algorithm. The terminal receives the first random data (R1, R2, and n) and generates the session key in the same way as the host using the terminal intrinsic secret key (KT[n]). Namely, Ks=Encrypt (R1, KT[n]).

STEP 22: The terminal generates the second signature value S1t=Sig (R2, Ks) by the signature generation algorithm, generates the second random data (R3), and sends S1t and R3 to the host.

STEP 24: The host can authenticate the terminal by comparing S1h with S1t. When the terminal is authenticated, the host generates the third signature value S2h=Sig (H+R3+Mode+Unit, Ks) and sends the third signature value to the terminal together with the mode information and the unit charge information. The terminal generates a fourth signature value S2t = Sig (H+R3+Mode+Unit, Ks) and authenticates the host by comparing S2h with S2t.

STEP 26: When the host is authenticated, the terminal converts a charge system, encrypts Balance+ID as M=Encrypt (Balance+ID, Ks) and sends the encrypted value M to the host. The host authenticates the terminal once again by decoding the encrypted value M as Balance'+ID'=Decrypt (M, Ks) and comparing ID' with ID. When the terminal is authenticated, the balance is stored on the record file.

Finally, the flow of the use during days, weeks, or months and timer information check command (used in the monitoring of abnormal use) will be described in detail with reference to FIG. 3.

STEP 30: The host generates the first random data (R1, R2, and n) and sends the first random data to the terminal. The session key is generated by the key generation algorithm using the terminal intrinsic secret key (KT[n]). Namely, Ks=Encrypt (R1, KT[n]). The first signature value S1h=Sig (R2, Ks) is generated by the signature generation algorithm for the comparison during the terminal authentication. The terminal receives the first random data (R1, R2, and n) and generates the session key as done in the host using the terminal intrinsic secret key (KT[n]). Namely, Ks=Encrypt (R1, KT[n]).

STEP 32: The terminal generates the second signature value S1t=Sig (R2, Ks) by the signature generation algorithm, generates the second random data (R3), and sends S1t and R3 to the host.

STEP 34: The host can authenticate the terminal by comparing S1h with S1t. When the terminal is authenticated, the host generates the third signature value S2h=Sig (H+R3+Time, Ks) and sends the third signature value to the

terminal together with Time. The terminal generates a fourth signature value S2t=Sig (H+R3+Time, Ks) and authenticates the host by comparing S2h with S2t.

STEP 36: When the host is authenticated, the terminal encrypts an information file (Info) including use details (Log), a differential charge mode table (ModeTB), a terminal time (Timer), the balance (Balance), and the ID.

Namely, the terminal encrypts the Info by M=Encrypt (Info, Ks) and sends the encrypted value M to the host. Here, Info=Log+ModeTB+Balance+ID. The host authenticates the terminal once again by decoding the encrypted value M by Info'=Decrypt (M, Ks) and comparing ID' with ID. When the terminal is authenticated, the use during days, weeks, or months and timer information is backed up on the record file and checked.

The value transmit and store encryption algorithm applied to the present invention was described as mentioned above. In order to be applied to a real electric power meter, the following items must be considered.

The maximum number of the value store electric power meters which can be connected to one pole transformer is restricted to 256. In a pole transformer for converting 3.3KV into 220V supply voltage, one local service & surveillance unit (LS) manages 250 value store electric power meters. LSs having different serial numbers are connected to the second side of the various pole transformers. One area service & surveillance unit (AS) connected to a maximum of 256 LSs can manage 65536 value store electric power meters. In managing the 256 LSs, one local server in a tree structure can manage up to 16,000,000 ASs. However, considering the performance and efficiency of the server, it is preferable that the maximum number of the value store electric power meters managed by the local server be restricted. An ID of 3 bytes is given to a general power line modem user and to the electric power meter modem (micom) for the case in which a signal goes over the pole transformer to the other side of 220V. A micom having a bus scrambling function protects an encryption algorithm and an encryption key, prevents appropriation, or can selectively use a secure access module (SAM) which is an IC card of a subscriber identification module (SIM) type. An electric power amount calculation, a token tank, and a display can be performed using an additional microcontroller. At this time, it is checked whether the control of the

LCD display and the electric power use calculation is hindered when the electric power amount meter communicates with the host. It is considered that there is a time limit in providing time information to the electric power meter. Namely, when it is assumed that it takes one second to transfer time information to a family, it takes one hour to transfer the time information to 3,600 families. A real time clock is loaded in the electric power meter and differential charges are applied according to the times. The clock time is corrected and monitored at all times. The abnormal use of electric power is monitored or digital sealing is used for a case in which tapping or hacking is performed by connecting the power line modem to a PC.

The digital sealing is systematically realized by compounding software and hardware. The digital sealing for monitoring the abnormal use of the electric power is realized by a method in which the terminal transmits details of the used power amount at a point in time, for a period of hours days, weeks, or years to the server as 2.44 kilobyte of information. The server records the information in a database, compares the recorded information with the information to be transmitted at the next point in time, and compares the comparison result with the total amount of used electric power for the same period. When a voltage is applied to an output terminal at the state where a latch relay cuts off electric power, it is determined to be a surreptitious use of electricity. Accordingly, emergency information is transmitted to the server.

The total of the electric power use details of the server can be utilized as a basis for making an agreement on prices advantageous to a re-contract by applying a reserve ratio during the purchasing of the electric power by estimating the electricity use for period of days, months, or seasons on the basis of the total amount of electric power used for a period of hours, days, months, or seasons.

When a circuit breaker breaks the supply of electric power due to the stored credit value becoming exhausted, a break by over current, a break in a special case, or the use of the electric power by tapping a power source at the front end of the meter, the abnormal use of electric power, is detected by a method of checking the presence of a load voltage.

The credit value is transmitted and stored in the electric power meter, the gas meter, the water meter, and the calorimeter via the power line modem. The electric power credit value is stored in the SVM and the remaining values are stored in the respective regions of the IC card electronic purse.

Hereinafter, the structure and operation of the electric power meter, made considering the above items, will be described in more detail with reference to FIGs. 5 through 7.

FIG. 5 shows the electric power meter which transmits and stores value information through the electric power line modem. In FIG. 5, a latch relay 1 is an on/off latch type relay switch for breaking the supply of the electric power. A shunt resistor 2 measures an alternating current (AC) by a manganese (Mn) resistance of 0.1mΩ. When the latch relay 1 is broken, a power consumption sensor 3 senses normal use when the output of the sensor is "0" and that terminals 1s and 1L are bypassed and the electric power is surreptitiously used when the output of the sensor is "1". A buzzer 4 requests a new token of credit value to the SVM after the balance of a token exchanger 10 is consumed and generates an audible alarm, thus guiding the credit value transmission and storage by an electric power user. A credit value/added value storage IC card 5 registers the card serial number (CSN) of a subscriber IC card on a management database by the master key of the electric power re-seller managing the credit value store electric power meter according to the present invention and checks the presence of a registered legal CSN when the server is requested to transmit credit value, thus preventing the illegal use of electric power.

A voltage divider 6 adjusts 117, 220, and 240V AC voltages to be within the input voltage range of a voltage analog to digital converter (V-ADC). The range of the voltage is selected by the ratio of two resistors which are serially connected. A V-ADC 7 is a circuit for converting an AC voltage analog signal into a 16 bit digital signal. A current analog to digital converter (I-ADC) 8 is a circuit for converting an AC current signal which flows through the shunt resistor 2 into a 16 or 20 bit digital signal. An electric power consumption operating circuit 9 calculates the electric power (Watt) by multiplying the digital signal of the V-ADC 7 by the digital signal of the I-ADC 8 and converts the multiplication result into a

pulse number and width signal. The electric power consumption operating circuit 9 compares the phase of the voltage with the phase of the current, calculates an angle by which the two phases are different, and outputs a phase difference as a signal, thus applying differential charges to the things which temporarily use induction load. The token exchanger 10 reduces tokens according to the amount (Watt/hour) of the electric power consumed per unit time, requests new tokens from a ten unit token tank when the tokens inside the token exchanger 10 are consumed, and reduces the new tokens according to the amount of power consumption. If the ten unit token tank is consumed, 100 unit tokens are requested for the SVM to be described later and the 10 unit token tank is filled again. The tokens requested for the SVM 166 can be received through the authentication process of the SAM 164. An RTC and power consumption table 11 performs a differential operation of multi-step electric power charges according to an electric power supply and demand situation of 50%, 75%, 100%, 150%, and 200% based on a real time clock comprised of year, month, day, hour, minute, and second (YYMMDDHHMMSS).

An IC card reader and recorder 12 conforming to ISO 7816 is a communication port comprised of eight terminals defined by ISO 7816 Part 2 including Vcc, Cik, DIO, Reset, and Gnd for synchronously and asynchronously communicating with the IC card. Multi-purpose credit values for things such as electric power, gas, water, hot water, heat energy, and pay-TV are recorded on one IC card by inserting a normally issued IC card into the electric power meter in an on line/off lines state. After recording the value transmitted from the gas service server through the value transmit and store electric power meter on the IC card, the IC card is taken out, inserted into the gas meter and the value information is transmitted to the gas meter, thus reducing the value information on the card according to the amount of gas use. Accordingly, the value transmit and store electric power meter can be operated in an off-line state.

A power line modem 13 performs data communication through the power line. Each modem is set by one among 256 power line modem ID addresses (PLMID). An AC/DC power source 14 supplies an operation voltage required by the value store electric power meter according to the present invention. The three

byte ID which is an intrinsic number of the value store electric power meter is recorded on a ROM during production. A non-volatile memory 15 comprised of a flash memory records an electric power consumption situation during a certain period, i.e., the details of the electric power consumption for 24 hours are found by recording the amount of electric power consumption of the value store electric power meter as 16 bit information every sixty seconds, the details of the electric power consumption for a week by adding seven total amounts of the daily electric power consumption together, and the details of the monthly electric power consumption by adding thirty total amounts of the daily electric power consumption to each other, monitors the surreptitious use of electric power or the abnormal consumption of electric power from a remote distance, and performs the electronic sealing. A scrambled bus 16 including a central processing unit (CPU) 162, a secure access module (SAM) 164 for keeping an encryption key and an encryption algorithm for storing credit value, and a store value module (SVM) 166 for storing credit value, prevents the fabrication and use of credit value information, and hacking and excludes a cryptographical attack. A liquid crystal display LCD 17 displays the balance of the credit value, a transmission state, a real time electric power consumption situation, and an accumulative electric power consumption situation so as to be distinguished visually by a user. A power line input and output terminal 18 is comprised of 1s, 2s, 2L, and 1L for connecting the input and output lines of the electric power to each other and a cover for preventing physical tapping. An arrester 19 is a circuit for absorbing lightning or a surge voltage.

An electric power meter for measuring electric power of a particular kind was described above. However, the electric power meter according to the present invention can measure the electric power of at least two kinds by including the voltage divider 6, the V-ADC 7, the I-ADC 8, the latch relay 1, and the shunt resistor 2 according to the kind of the electric power. Namely, when the voltage divider, the V-ADC, the I-ADC, the latch relay, and the shunt resistor are combined so that at least two kinds of power sources with different voltages can be selectively or simultaneously used, the respective amounts of current being additionally measured and operated.

The operation of the value store electric power meter having the above structure is described as follows. As mentioned by the electric power supplier or the electric power re-seller, the credit value from the host is stored in the SVM 166 of each terminal through the power line modem 13 using the credit value store method, each electric power meter calculates charge according to the amount of electric power consumption operated on by the electric power consumption operating circuit 9, compares the calculated charge with the balance of the credit value information stored in the SVM 166, and calculates the charge through the token exchanger 10. When a balance of not more than a certain amount is left in the SVM 166, the user is informed of the balance state by sounding a buzzer. When the balance is insufficient, the credit value is transmitted from the host to the SVM 166 by the above-mentioned credit value store method or the power supply is broken by operating the latch relay 1. The credit value information can be stored in the SVM 166 by communication between the host and the terminal in the value store electric power meter according to the present invention. However, it is possible to transmit the electric power value information stored in the IC card 5 to the SVM and store the transmitted information in the SVM by inserting the electric, gas, water, and calorie IC card 5 for a family or an establishment to which a legally issued certain amount of money is recorded into the value store electric power meter according to the present invention.

That is to say, the electric power meter according to the present invention displays the information such as monthly consumption amount and card balance on the LCD 17 installed therein by using a certain amount of electric power in a value range recorded in the SVM, and sounds the buzzer 4 when the balance of no more than a certain amount is left in the card. Accordingly, the user requests the server to transfer the credit value. The credit value is automatically charged to an account of a previously contracted bank or settled by a credit card. The electric power value is received on-line through a power line and stored in the SVM 166. The value is reduced according to a power use scale.

Accordingly, the electric power supplier and the electric power re-seller can save costs by omitting processes of reading a meter, inputting and calculating the amount of use, and printing and mailing a bill. A power bill is paid in advance.

Accordingly a process of re-charging arrears is omitted. Also, it is possible to lower the power bill due to benefits from pre-payment interest, application of differential charges according to the electric power use time, and the cost saved in the difference between an electric power purchasing price and an electric power selling price. The electric power seller can manage a high value added business.

In order to prevent the use of a fabricated card other than an IC card legally issued by the electric power supplier or the electric power re-seller, the SAM 164 for authenticating the card is loaded into the electric power meter. When the card is inserted into the terminal, the terminal and the card authenticate each other. When the amount of money information on the card is transferred by the terminal as the credit value, the terminal operates according to the encryption process shown in FIG. 1. Accordingly, the use of the fabricated card is prevented. A method of volatilizing an encrypted key, thereby disabling the terminal, during the dismantling of the meter can be considered against the cryptographic attack of a hacker, for example, the dismantling of the value store electric power meter in order to fabricate the terminal or the card. However, the encryption algorithm and the encrypted key inside the terminal have only an amount reduction key in which the credit value information is reduced according to the amount of the power consumption. Accordingly, it is not possible to increase the money or the credit value information. In particular, in the present invention, when a user/a subscriber contacts an ARS server through a telephone or a digital interphone in order to request a transfer of credit value, the use amount is selectively settled using credit card or bank account. The value transferring process starts within a range in which the payment is guaranteed. The process can also be performed through Internet. In particular, it is possible to automatically transfer the value when the value stored by the account automatic transfer contract between the electric power seller/the electric power re-seller and a financial institution is reduced to a certain scale, and for people who have never used a computer or information communication network. In particular, in the case of performing a payment request trade by an SET electronic trade process with a direct payment card, the server operating as a cybermall may put trade details into a digital envelop (DE),

which has the effect of signing the trade details. Accordingly, the trade process cannot be denied or fabricated.

The realizing process and condition of the above-mentioned present invention will be described in detail hereinafter.

1) Processes of generating, transferring, and storing credit value

Credit value information is generated by communicating and operating with the subscriber management database using the masterkey (Mk) of the electric power seller or the electric power re-seller. The ID number of the subscriber which is requested by a power line LAN modem is selected through area service & surveillance (AS) and local service & surveillance (LS). When the request for the subscriber ID number and the communication are completed, the legality of the server and the terminal is authenticated by the above-mentioned authentication process. When the authentication is completed, the requested credit value information is transferred. The credit value information transmitted through the power line is stored in the store value module (SVM).

2) Processes of transferring and storing added value

The efficiency of the present invention is increased by adding an added value transfer function which can be used in connection with power, gas, water, calorie, and hot water meters operating off-line by the IC card without a separate communication line. The generation and transfer of the added value are performed by the above-mentioned processes of generating and transferring the value. The added value is stored in the IC card instead of the electric power meter. The added value information for things such as gas, water, hot water, and heat energy stored in the IC card can be operated on, inserted into IC card off-line water and gas meters which are compatible with the IC card provided in the Korean Patent Application Nos. 98-6947 and 98-6948 filed by the same applicant. Accordingly, the efficiency of management is maximized.

3) Consumption of credit value information

The credit value information stored in the SVM 166 is reduced in a token exchanger (TE) 10 according to the amount of power consumption. The token is reduced per unit time by several miliWatts, several watts, or several kilowatts.

When the token of a minimum unit is exhausted, the credit value information is reduced by a process of requesting a new token.

4) Differential application of power consumption rate

An electric power use mode which can differentially apply multi-steps of electric power use rates according to time zones of weekdays and weekends, seasons, and months in which the amount of credit value used is selected by a program and automatically applied. In the electric power consumption mode table 11 various rates can be differentially applied, according to the time zones and the characteristics of the supply and demand of electric power and electric power supply and use, for example, 100% at daytimes of weekdays, a discount of 75% before and after the daily work times of the weekdays, a discount of 50% at midnight, a premium of 200% at daily work times, and a premium of 300% at 2 to 4 p.m. in summer during which the use of air conditioners rapidly increases is applied by a real time clock (RTC). Since the separate TE 10 is applied with respect to the same amount of electric power use, the stored credit value is differentially applied. Accordingly, the consumption of electric power becomes optimal during each time zone. Thus, the efficiency of the supply and demand of electric power is maximized. Therefore, the electric power bill is reduced.

5) Balance checking and automatic breaking

The credit value information of the SVM 166 is displayed on a display device such as liquid crystal so that a user can check the balance at any time. When the credit value is exhausted, the token exchanger informs the user that the last tokens are being used by sounding an alarm of an audible frequency. When the credit value is not re-charged before the last token is consumed, the supply of the electric power is broken by sending a break signal to the latch relay serially connected to the power line.

In order to satisfy the above-mentioned various realization processes and conditions, the present invention can be used in connection with the various gas and water meters where it is possible to transfer the added value by the IC card on the basis of the value transfer and value store electric power meter with which it is not necessary to read a meter based on the following structures and principles.

The value store electric power meter according to the present invention measures a voltage (V) and a current (A) in real time, calculates the amount of electric power (W) using the electric power consumption circuit, measures the consumption of electric power per unit time, converts the stored value information into a token, reduces the token according to the amount of consumption of electric power per unit time in a token exchanger 10, and requests new credit value information when the token is exhausted. Also, all the information the user should know such as the amount of remaining credit value information and a power consumption state is displayed through a liquid crystal display screen 17. When the last credit value information is converted into token form, the user is informed by sounding an alarm having an audible frequency. Accordingly, the credit value is re-charged. When the inner credit value information is exhausted, the supply of the electric power is broken by breaking the latch relay 1.

In the mode table (MT) 11 by which it is possible to differentially apply the electric power rate by at least five steps, the real time clock (RTC) differentially applies the electric power rates of various steps such as 50%, 75%, 100%, 200%, and 300% according to the time zone and reduces the credit value information. Namely, though the same electric power is used per unit time, the credit value of the SVM is differentially reduced since the TE 10 applies multiple steps of electric power rates by a time program defined in the MT credit. Accordingly, the consumption of electric power becomes optimal during each time zone. Therefore, the supply and demand of electric power are well balanced. A discount benefit according to the selective use by the user is given by the multiple step electric power fare system. For example, a discount for night times at which the supply of electric power is excessive can lower the power supply reserve rate of the power supplier. When offices intensively use air conditioners in summer, a premium power fare is charged and a heat storage system is induced. Accordingly, it is possible to give a discount benefit to the electric power consumer such as a home or an establishment.

The value store electric power meter according to the present invention has a scrambled data bus structure in which a CPU 162 and an inner memory cannot be read by a lay person in order to prevent the stored value from being fabricated

and cryptographically attacked. The value store electric power meter is comprised of the secure access module (SAM) 164 into which the secret intrinsic key (KT[n]) and the encryption algorithm can be loaded and the store value module (SVM) 166. Should the hacker or the encryption attacker dismantle the electric power meter in order to fabricate the credit value information, the encrypted key and the encrypted algorithm of the SAM and the SVM cannot be seen. The SAM, the SVM and the master key (Mk) of a host computer are mutually authenticated. Thus, the SAM and the SVM can transfer and store the credit value information by the above-mentioned processes using the master key. The SAM and the SVM can store credit value information and added value information in the IC card using the master key. When the IC card is inserted into the electric power meter, an answer to reset (ATR) signal is received by sending a reset signal to the card, the IC card and the terminal are mutually authenticated, the credit value information is exchanged through the SVM and the SAM, and the credit value information is calculated with respect to the legal use of the IC card. The credit value information is recorded by a separately encrypted key (Mk) of an issuer. Therefore, it is not possible to increase the credit value. Such processes are performed in compliance with the international standard organization (ISO) 7816 Part1, Part2, Part3, Part4, Part8, and Part10 and contain a physical standard, an electric signal, a communication protocol, and an encryption process. At least two encrypted keys are stored according to the request of the manager. One encrypted key is updated by a distance of a certain time. The encrypted key is selectively used. Accordingly, the fraudulent use of the credit value is prevented.

The transferal of the credit value and the added value and the monitoring of the legal use of the value are performed through an electric power modem. A power consumption sensor circuit is provided and power use information is recorded in a non-volatile memory (NVM) 15 in order to monitor the surreptitious use of electric power and punish illegal use without having to visit a place in which an electric power meter is installed and checking lead or tartar sealing. Such a circuit can be periodically monitored by the LS and the AS, thus performing an electronic sealing function without checking the physical lead sealing.

The value store electric power meter has a value store power meter serial number (SVPMSN) of 3 bytes. The electric power modem 13 communicates with the LS by a modem identification number (M-ID) address of 1/256. When the server of the electric power seller or the electric power re-seller sees a request to transfer the value, it starts a short-distance communication with the value store electric power meter of the subscriber according to an addressing process for selecting the M-ID of the subscriber.

The subscriber requests the transfer of credit value by contacting the ARS of the electric power seller or the electric power re-seller by telephone or a digital interphone 20 and a keypad 21, selecting the settlement by credit card or bank account, and selecting the payment of the transferred electric power credit value. Then, a credit value managing server is requested to transfer the credit value by the AN given by the server of a credit card company. The credit value managing server of the electric power seller calls the M-ID through the AS and the LS, transfers the credit value to the SVPM and stores the transferred credit value by performing the above-mentioned value storing processes.

The LS sequentially monitors the power consumption state of up to 256 value store electric power subscribers through the electric power modem connected to the 117V/220V electric power line at a maximum distance of 3Km. The LS sequentially calls SVPMs of address 1/256 · · · n/256, checks and re-controls the internal real time clock change state of the SVPM, controls a rate system mode, checks the CSN of the card, backs up the balance of the credit value, checks the presence of surreptitious and abnormal use of electric power, and downloads reports on the electric power consumption during days, weeks, or months, thus totalizing and estimating demand for electric power. The totalization and estimation results are used as guides for negotiating the price of purchasing electric power and re-controlling the price of supplying electric power.

In the transferal and storage of the credit, the gas, water, heat and hot water meters other than the electric power meter consist of a meter which operates off-line by using the IC card, without a separate communication line since these installation environments are inferior and a line construction is very complicated. When the added value information transferred through the value

store electric power meter is stored on the IC card and the IC card is inserted into the water, gas, and heat meters, added value information is stored in each meter. The tokens are reduced by the same credit value reducing processes. When the credit value information is exhausted, a valve for stopping the supply of gas, water, heat, and hot water is closed. The efficiency of the present invention is increased with the added value transferring function in which it is possible to use the value transfer and store electric power meter together with the added value service. The added value is generated and transferred by the same processes of generating and transferring the credit value. The added value is stored on the IC card instead of in the electric power meter. The added value information for things such as gas, water, hot water, and heat, is stored on the IC card by performing the above processes, and can be transferred into the IC card off-line water and gas meters which can hold the IC card provided in Korean Patent Application Nos. 98-6947 and 98-6948.

Hereinafter, credit value transfer request and processes in the electric power modem will be described with reference to FIG. 6.

A subscriber IC card 52 is issued to those who wish to receive the IC card, by using a master key IC card 51 of the system manager in an electric power re-seller 50. After settling the credit value for things such as electricity, gas, water, hot water, and heat energy in cash or by credit card on the spot, a first credit value is stored on the IC card. The electric power credit value on the card is stored in the electric power meter by inserting the IC card into the value store electric power meter of a user 55. When the IC card is inserted into the gas, water, hot water and heat energy meters of the user 55, the credit value is stored in each meter. After the first credit value storage, further credit value/added value storage is performed by the value transferring process using the electric power modem. The value transferring and storage can be performed using the telephone, the Internet, a P-ATM (EMV '96), and the value store electric power meter. The processes of transferring and storing the value are performed with the above-mentioned encrypted algorithm forming. The credit value/added value transferring channel is as follows. The subscriber record information is taken from the subscriber database of the host server of the electric power re-seller 50. The

payment to a bank or a VAN company is guaranteed, by a user selecting one among a credit card number, a direct payment card number, and a bank account number. The credit value information is encoded by the master key of the SAM. The ID of the subscriber value store electric power meter is called through the AS and LS networks. The SAM and the master key are mutually authenticated. Then, the credit value/added value information is transferred. The local surveillance unit (LS) downloads the electric power use record for a period of hours, days, weeks, or months from the value store electric power meter, monitors the state of electric power use and the balance of credit value on an hourly or daily basis, resets time, downloads the electric power use mode and program, and monitors the surreptitious and abnormal use of the electric power. Also, the amount of money calculation is performed between an amount of money calculation system 54 of an electric power seller 53 and the electric power re-seller 50 by a method similar to the above-mentioned processes.

FIG. 7 is an exploded perspective view showing the outer shape of the value store electric power meter according to the present invention. The value store electric power meter according to the present invention includes an LCD display 17 on the upper portion of a front surface and an input and output terminal 66 on the lower portion of the front surface. The input and output terminal 66 is connected to the electric power line for inputting and outputting electric power and is covered with a surreptitious use prevention cap 64. A digital interphone 20 and a value transfer requesting key pad 21 are provided on the upper surface of the surreptitious use prevention cap 64. Also, an IC card inserting slit 60, into which the IC card is inserted, is formed in one side of the electric power meter. The credit value is stored in the IC card and is read from the IC card when it is inside the IC card inserting slit 60. Also, a surreptitious use/dismantle checking sealing unit 62 for sealing the electric power meter so that electric power cannot be surreptitiously used, is part of the electric power meter.

As described above, the present invention has been described only with respect to the value store electric power meter via the power line modem. Mutual necessary information can be exchanged via power line modem communication between the server and the terminal. A general telephone line, a radio frequency

relay communication line, and a cable TV line can be used instead of the power line.

As mentioned above, according to the present invention, it is possible to reduce visiting personnel expenses by omitting the process of reading meters for things such as electric power, gas, water, and heat energy, compute processing expenses, print and mail bills, and bill for mailing expenses.

Also, it is possible to reduce loss due to uncollected electric power bills and arrears, and to give added value since the credit value is paid for in advance by a credit card or from a bank account. Accordingly, a power supplier can give a high added value.

The present invention describes a composite electric power meter with which it is possible to solve the economic and security problems of having to visit and visually examine a conventional remote electric power meter.